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This document presents the final report for the USUSat III program funded by the Air Force Office of Scientific Research. The goal of this program has been to develop a next generation of engineers and scientists with skills in space systems. This objective was to be accomplished through a design and fabrication competition between university teams. The competing teams were all sponsored in the University Nanosatellite Program by the Air Force Research Laboratory and the Air Force Office of Scientific Research. The winning team was determined by a panel of judges at the Final Competition Review in March of 2007. The USUSat III was not ranked among the top three proto-flight spacecraft and was not selected to be developed for flight.

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Final Report: USUSAT III – TOROID

TOmographic Remote Observer of Ionospheric Disturbances

Final Report for the Period Oct 1, 2006 to Apr 30, 2007

AFOSR University Nanosat Program

Center for Space Engineering
Utah State University

Principal Investigator:
Charles Swenson

Student Program Managers:
Matthew Carney,
Jared Clements,
Karl Burk

USUSat III – TOROID

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1 Report Overview

This document presents the final report for the USUSat III program funded by the Air Force Office of Scientific Research. The goal of this program has been to develop a next generation of engineers and scientists with skills in space systems. This objective was to be accomplished through a design and fabrication competition between university teams. The competing teams were all sponsored in the University Nanosatellite Program by the Air Force Research Laboratory and the Air Force Office of Scientific Research. The winning team was determined by a panel of judges at the Final Competition Review in March of 2007. The USUSat III was not ranked among the top three proto-flight spacecraft and was not selected to be developed for flight.

This report is divided into four sections. The next section, 2, presents a very brief overview of the USUSat III program and is intended for those unfamiliar with the specific goal of Utah State's program. Section 3 of this report presents an overview of the student involvement in the program. It overviews the leadership roles students played and presents a snapshot of the USUSat III team and their roles and how they were filled at the end of the program. It also includes a list of the reports and thesis generated under this grant. A brief review of the hardware status is presented in section 4 which is largely a synopsis of the report attached as appendix A and presented at the final competition review. The final section presents a set of lessons learned from the USUSat III program.

2 USUSat III Program Review

The USUSat III program is a continuation of the USUSat II program that began in 2003 as illustrated in Figure 1. The USUSat III program made use of the hardware developed for the USUSat II program with the addition of a new instrument and expanded science mission. In turn, a significant amount of the flight electronics from the USUSat II program was inherited from the earlier USUSat program that ran from 1999 to 2002.

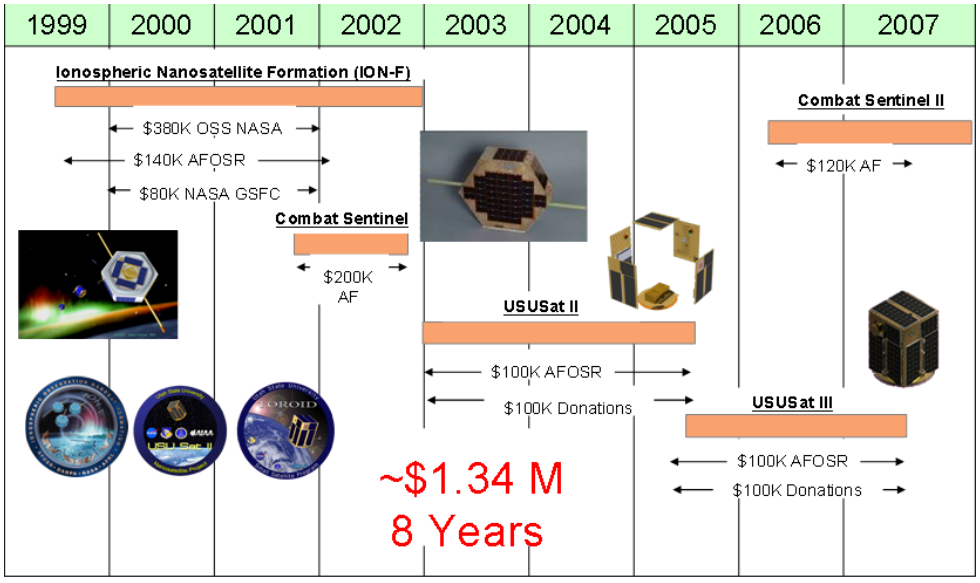

Figure 1 Utah State University Nanosatellite Program

The proposed science mission for USUSat III has been one of interest to both NASA and the Air Force and involves a study of disturbances in the Earth's ionosphere. The proposed spacecraft was an evolutionary design from the USUSat, Combat Sentinel, and USUSat II programs whose histories are shown in Figure 1. The primary science instrument, TOROID for TOmographic Remote Observer of Ionospheric Disturbances, is a photometer for measuring the airglow due to electron and oxygen ion recombination in the 150 to 600 km altitude region. The data are to be gathered in such a way that tomographic techniques can be used to construct an altitude profile of ionospheric density along the spacecraft trajectory. This project intended to develop, explore and demonstrate new small satellite technologies particularly in the area of spacecraft manufacturing and modularity as well as gathering meaningful scientific data. The USUSat III - TOROID Mission Statement is:

TOROID shall measure vertical profiles of the night time ionospheric plasma density distribution in the Equatorial Anomaly through tomographic reconstruction of extreme ultraviolet night glow. TOROID shall also demonstrate the advantages of additive technologies for small satellite manufacturing.

The need to strengthen educational and research programs in the United States to support the space industry was the underlying purpose of the Air Force University Nanosatellite Program. The USUSat III - TOROID program was proposed to be right in line with these Air Force objectives. The USUSat III program made use of graduate and undergraduate students as program managers, team leaders, engineers, and technicians. The students were supported by faculty from USU and by professional engineers at the Utah State University Space Dynamics Laboratory (SDL). The lessons learned in using student teams on USUSat, Combat Sentinel, and USUSat II were applied to maximize student training in spacecraft systems while producing as flight ready space hardware as possible.

3 Student Participation

The USUSat III program involved students from the Electrical and Computer Engineering (ECE) and the Mechanical and Aerospace Engineering (MAE) Departments. A few students from the physics and other departments also participated although they did not fulfill any significant leadership roles within the program. The funding level of the USUSat III program allowed for only a few students to be directly paid on the program and only at part time levels. Those receiving funding included the student project leadership and a few key subsystem leads. The rest of the student involvement was on a voluntary basis or through thesis research and senior design projects. None of the professional staff was compensated by the program meaning that their participation was a donation to the program.

3.1 Student Leadership

The USUSat III program was organized with a student program manager and systems engineer leading the student team. Key subsystem leads had groups of students working on individual or team projects under their coordination. The student program manager reported to the principle investigator, a faculty member and the PI on this AFOSR grant. The student team was supported by faculty from USU and by professional engineers and

technicians at the Utah State University Space Dynamics Laboratory. Essentially the students could go to these supporting individuals for advice and to receive technical training, detailed review of designs, training on equipment, instruction, etc.

3.2 Student Team

The USUSat III student team was large and spanned both undergraduate and graduate students. It was also dynamic and in continual flux with students graduating or moving on to other research opportunities within USU. Initially, a large percentage of the students who assumed leadership roles had been involved with the previous USUSat II or other programs and were trained in the USUSat culture. Towards the end of the program the students taking on leadership roles were those that had been initial volunteers within the USUSat III program. In total more than 82 individuals can be claimed as being part of the USUSat III effort. The bulk of the work has been carried by approximately 30 individuals participating in the effort with approximately 16 individuals holding key leadership roles over the duration of the program. About 1/3 of the core students on the program were graduate students pursuing some form of masters degree with two PhD students contributing in small ways. A snapshot near the end of the program of individuals and their assigned roles along with students who participated in USUSat III are presented in Table 1.

Table 1 List of students participating in the USUSAT III program

Current Roster					
Program Manager	Matthew Carney				
I&T Authority	Jared Crace				
Configuration Author	Matthew Carney				
Systems Engineer	Ben Galloway				
Systems Engineer	Daniel Perkins				
Systems Engineer	Jana Coakley				
Systems Engineer	Jared Crace				
Systems Engineer	Jared Clements				
Staff					
		Total	**Grad Students**	**Upper Classmen**	**Lower Classmen**
		82	**15**	**30**	**37**
Sub-system	**Name**		**Major**	**Year**	**Email**
00_Systems	Matthew Carney	Active	Electrical Engineering	Graduate Student	mdcarney@cc.usu.edu
00_Systems	Daniel Perkins	Active	Electrical Engineering	Junior	dlp@cc.usu.edu
05_Operations					
10_Structure	Quentin Alldredge	Active	Mechanical Engineering	Graduate Student	quentin@cc.usu.edu
20_C&DH	Paul Rodriguez	Active	Computer Engineering	Senior	paulrod@cc.usu.edu
25_Software	Jared Crace	Active	Electrical Engineering	Graduate Student	jaredcrace@gmail.com
30_Comm	Matthew Carney	systems			
35_Ground Station	Karl Burk	Active	Mechanical Engineering	Senior	karlburk@cc.usu.edu
35_Ground Station	Nate Crookston	Active	Electrical Engineering	Senior	nrc@cc.usu.edu
40_Power	Joshua Daley	Active	Electrical Engineering	Senior	joshuadaley@gmail.com
45_GSE					
50_ADCS	Scott Jenson	Active	Mechanical Engineering	Graduate Student	ssrj45@yahoo.com
50_ADCS	Toby Johnson	Active	Electrical Engineering	Senior	tmanley@ieee.org
60_Mechanisms	Ryan Smith	Active	Mechanical Engineering	Graduate Student	ryanjosmith@yahoo.com
70_Harness					
80_Thermal	Jared Clements	Active	Mechanical Engineering	Graduate Student	jwc@cc.usu.edu
90_Science	Jaya Shankar	Active	Electrical Engineering	Graduate Student	jaya@cc.usu.edu
90_Science	Jonathan Howell	Active	Mechanical Engineering	Sophmore	jonathhowell@cc.usu.edu
90_Science	Blair Leonard	Active	Electrical Engineering	Junior	blairleonard@cc.usu.edu
90_Science	Doug Ahlstrom	Active	Electrical Engineering	Senior	ahlstrom@cc.usu.edu
90_Science	Josh Soelberg	Active	Mechanical Engineering	Junior	jsoelberg@cc.usu.edu

Volunteers					
	Aaron Anderson	Active	Physics	*Junior*	andersena@gmail.com
	Adam Hyde	Active	Mechanical Engineering	Sophmore	hydeinbrasil@yahoo.com
20_C&DH	Andrew Moss	Active	Electrical Engineering	Junior	abmoss@cc.usu.edu
	Andy Olsen	Active	Mechanical Engineering	Sophmore	hiss_andy@hotmail.com
00_Systems	Ben Galloway	Active	Electrical Engineering	Senior	BMGALLOWAY@cc.usu.edu
	Brian Solomon	Active	Mechanical Engineering	Graduate Student	brianjsolomon@gmail.com
30_Comm	Bryan Willis	Active	Electrical Engineering	Graduate Student	bryanjw@cc.usu.edu
	Bryce Wheeler	Active	Electrical Engineering	Sophmore	bwheeler@hass.usu.edu
	Chris Smith	Active	Mechanical Engineering	Sophmore	cesmith@cc.usu.edu
	Cody Gabaldon	Active	Mechanical Engineering	Freshman	cgabaldon@cc.usu.edu
10_Structure	Cormac McCarthy	Active	Mechanical Engineering	Sophmore	cmzero@gmail.com
10_Structure	Dallin Stephens	Active	Mechanical Engineering	Freshman	dallin.stephens@yahoo.com
	Dan Christensen	Active	Mechanical Engineering	Sophmore	danc435@yahoo.com
	David Walk	Active	Mechanical Engineering	Sophmore	dwalck@cc.usu.edu
	Doug Standart	Active	Mechanical Engineering	Freshman	dougstandart@cc.usu.edu
00_Systems	Heather Smith	Active	Biological Engineering	Graduate Student	haveadelightfulday@yahoo.com
50_ADCS	Jacob Hatch	Active	Electrical Engineering	Senior	JFH@cc.usu.edu
35_Ground Station	Jaime Fernandez	Active	Electrical Engineering	Graduate Student	jmfh7383@gmail.com
50_ADCS	Jake Talbot	Active	Electrical Engineering	Junior	benjt@cc.usu.edu
00_Systems	Jana Coakley	Active	Electrical Engineering	Junior	jcoakley@cc.usu.edu
	Jared M. Lyman	Active	Electrical Engineering	Freshman	jaredmlyman@cc.usu.edu
	Jason Rowsell	Active	Physics	Freshman	jqr_smartboy@hotmail.com
	Jeff Anderson	Active	Mechanical Engineering	Sophmore	jsa@cc.usu.edu
	John Pratt	Active	Electrical Engineering	Junior	johnpratt@cc.usu.edu
30_Comm	Jonathan R. Haws	Active	Electrical Engineering	Junior	jon@hawsfarm.org
	Jordan Brimley	Active	Mechanical Engineering	Freshman	shakeyourcoolthing@yahoo.com
	Jordan Iving	Active	Mechanical Engineering	Sophmore	jordi@cc.usu.edu
	Josh Templin	Active	Computer Engineering	Junior	jtemplin@cc.usu.edu
	Karma Hart	Active	Electrical Engineering	*Junior*	khart@cc.usu.edu
	Kelby Bosshardt	Active	Mechanical Engineering	Freshman	kbosshardt@cc.usu.edu
	Kyle Maybury	Active	Mechanical Engineering	Sophmore	kmaybury@cc.usu.edu
	Lance Hunter	Active	Electrical Engineering	Junior	hunter@cc.usu.edu
	Luke Andrew	Active	Mechanical Engineering	Sophmore	l.andrew@cc.usu.edu
	Marcus A. Cockerham	Active	Mechanical Engineering	Junior	marcusa@cc.usu.edu
	Maren Wilkerson	Active	Mechanical Engineering	Freshman	marenrw20@hotmail.com
	Mark Cook	Active	Electrical Engineering	Junior	mark.cook@usu.edu
	Michelle Fowles	Active	Mechanical Engineering	Freshman	mickie4004@yahoo.com
	Morgan Frampton	Active	Mechanical Engineering	Sophmore	morgfram@cc.usu.edu
	Peter Lieber	Active	Computer Engineering	Junior	peta@cc.usu.edu
	Quinn Jackson	Active	Electrical Engineering	Sophmore	qjackson@cc.usu.edu
	Raheel Aslam	Active	Mechanical Engineering	Sophmore	isolate_one@hotmail.com
	Rama Chaudra	Active	Electrical Engineering	Graduate Student	kvcreddy@gmail.com
	Richard Larson	Active	Electrical Engineering	Sophmore	rlar@cc.usu.edu
	Richard Wilson	Active	Mechanical Engineering	Sophmore	RichardW@cc.usu.edu
	Robert Barnes	Active	Computer Engineering	Senior	robcb@gmail.com
	Robin Bailey	Active	Electrical Engineering	Junior	robinbailey@cc.usu.edu
	Sam White	Active	Mechanical Engineering	Freshman	samw@cc.usu.edu
	Samantha Loveless	Active	Mechanical Engineering	Freshman	samamish1@yahoo.com
	Scott Needham	Active	Computer Engineering	Sophmore	needhamizer@gmail.com
30_Comm	Scott Redd	Active	Electrical Engineering	Junior	sredd@cc.usu.edu
	Slobodan Nikolic	Active	Electrical Engineering	Sophmore	slobo@cc.usu.edu
	Srinidhi Kaveri	Active	Electrical Engineering	Graduate Student	srinidhi@cc.usu.edu
	Sriram Sridharan	Active	Electrical Engineering	Graduate Student	srirams@cc.usu.edu
	Swadesh Pahra	Active	Electrical Engineering	Graduate Student	swadeshpahra@cc.usu.edu
	Taehoon Kim	Active	Mechanical Engineering	Senior	taehoonkim@cc.usu.edu
	Taehoon Lee	Active	Mechanical Engineering	Senior	taehoon@cc.usu.edu
20_C&DH	Taylor Hoenes	Active	Electrical Engineering	Junior	Tayhoenes@yahoo.com
	Tim Gelter	Active	Electrical Engineering	Sophmore	tgelter@cc.usu.edu
	Tim Johnson	Active	Mechanical Engineering	Freshman	johnson.tim.m@gmail.com
	Trevor Foust	Active	Electrical Engineering	Sophmore	TrevorLFoust@cc.usu.edu
	Tyler Tribett	Active	Mechanical Engineering	Freshman	trib@cc.usu.edu
	Tyson Smith	Active	Mechanical Engineering	Senior	laser1450@hotmail.com
	Vicki Ragsdale	Active	Mechanical Engineering	Freshman	vragsdale@cc.usu.edu
	Wade Siddoway	Active	Mechanical Engineering	Sophmore	wades@cc.usu.edu
	Youssef Filali	Active	Electrical Engineering	Sophmore	locok2002@yahoo.fr

3.3 Student Reports

The following Masters of Science theses and reports were produced under this USUSat III grant. These were produced in addition to the formal University Nanosatellite Program reports and presentations. They represent a significant amount of the documentation of the effectiveness of this program in interesting students in space systems.

John Salmon, ECE, 2005, *Conceptual Design of a Far Ultraviolet Photometer for Tomographic Measurements of the Upper Ionosphere*

Jason Bingham, ECE, 2006, *A Digital Design for a Plasma Impedance Probe*

Matthew Carney, ECE, 2006, *The Design, Simulation, and Testing of the TOROID Communication System from a Systems Perspective*

Jared Crace, ECE, 2007, *TOROID Software Subsystem*

Scott Jensen, MAE, 2007, *The attitude determination and control system of the TOROID satellite*

Josh George, MAE, 2006, *Utilization of ultrasonic consolidation in fabricating satellite decking*.

4 Program Accomplishments and Spacecraft Status

Utah State University participated in the following University Nanosatellite Competition activities:

- Kickoff Meeting Telecon Mar 2005
- System Concept Review (SCR) Telecon Apr/May 05
- Student Hands-on Training Workshop (SHOT I) University of Colorado at Boulder June 05
- Preliminary Design Review (PDR) Small Sat Conference, Logan UT Aug 05
- Satellite Fabrication Class Air Force Research Lab, Albuquerque NM Oct/Nov 05
- Critical Design Review (CDR) On-site at each participating university Feb/Mar 06
- SHOT II Workshop University of Colorado at Boulder June 06
- Proto-Qualification Review (PQR) Small Sat Conference, Logan, UT Aug 06
- Flight Competition Review (FCR) Albuquerque, Mar 07

5 Hardware Status

The USUSat III / TOROID Spacecraft and associated systems are in a relatively well developed state given the cumulative efforts of the USUSat program as presented in Figure 1. Most of the spacecraft components have moved through the process of design, manufacture and testing as individual subsystems with the spacecraft as a whole being in a process of integration. The exceptions to this are the science instruments which were at

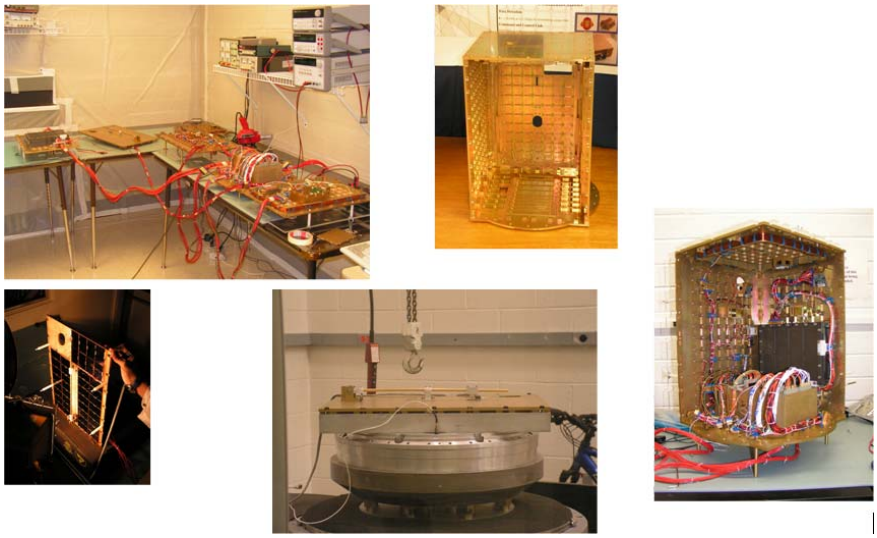

Figure 2 USUSat III modular spacecraft in various states of assembly and test

the beginning of fabrication at the end of the USUSat III program. Ground station components were on had and were used in the end-to-end testing of the spacecraft although the deployment of antenna's on roof tops was in progress and the acquisition of a high gain S-band system was not complete.

Images of the USUSat III spacecraft in various stages of assembly and under testing are presented in Figure 2. The upper left image shows the spacecraft in the "flat sat" configuration with each of the spacecraft component modules connected using long red test harnessing. The image on the right shows the spacecraft assembled with two of the modular sides removed to reveal the interior components. The other images show the spacecraft in various stages of testing; end to end power system testing, vibration testing of antenna deployment mechanism, and fit check of the modular structure. The status of each of the USUSat III components is briefly summarized below:

- Structure: Complete except for flight solar cells.
- Command & Data Handling: Complete and in end to end testing with other systems and software
- Communication: All hardware on hand and ground station components in assembly
- Power: Complete and tested
- Ground Support Equipment: Some mechanical equipment needs to be manufactured and the existing electrical equipment needs to be re-manufactured
- ADCS: All hardware on hand and beginning testing. Software algorithms under integration and testing with rest of flight software.
- Mechanism: Engineering unit tested, flight hardware being manufactured
- Harness: Engineering unit complete and all hardware on hand for flight harness
- Thermal: All hardware on hand
- Science Instruments: Beginning fabrication.

A major accomplishment of the USUSat III program this year was the development and testing of flight hardware. The climax for the student team was to be able to run the spacecraft hardware through a sequence test beginning with deployment from the launch vehicle through the initial TM contacts, attitude control, and into standard operations. This was a significant demonstration by the USUSat team for the judges at the Final Competition Review.

6 Conclusions and Lessons Learned

The results of the final competition review for the University Nanosatellite Program with the USUSat III spacecraft not finishing in the top three positions was a significant event for all involved at Utah State University. At the start of the competition USU had significant advantages with existing USUSat II hardware in hand and with a small group of experienced students to begin with. The team had strong potential support from both the Space Dynamics Laboratory and USU faculty members. Air Force personnel were indicating that it appeared to be USU's competition to lose which is exactly what happened two years later. This section presents some retrospective thoughts of the USUSat program, its success and its value to the students, faculty and institution. We review what worked and what failed throughout the USUSat III efforts and explore perhaps why other schools succeeded in winning the Air Force competition.

The AFOSR funded University Nanosatellite Program has effectively been the core, long-term research and educational small satellite program at USU. Because of its existence other programs or research opportunities have either been "spun out" or "attracted by" the USUSat effort over the past five years. These include the Air Force Space Battle Lab's Combat Sentinel program, The State of Utah Center of Excellence for Satellite Manufacturing, the Lockheed Martin Autonomous Nanosatellite Guardian Evaluating Local Space (ANGELS) satellite study at SDL, a conceptual design study for Sandia National Laboratory at SDL and a study of modular thermal systems for the Air Force Research Laboratory. The ability to demonstrate what a student program can achieve at an institution on very limited resources is a powerful tool in attracting new funded research associated with spacecraft systems. It has provided long-term connectivity to the satellite community and awareness of new research opportunities from which these programs have evolved. At an institutional level the USUSat has been a great success in stimulating new research and increasing the institutions reputation in space science and engineering. Unfortunately this has not always transferred to success for individual faculty donating time to USUSat while trying to grow their research. It has been determined to be an unwise investment of time by the administration for faculty concerned with achieving tenure or promotion at USU.

USUSat III has clearly been an outstanding success for students involved with the program. The anecdotal metric used for judging success is if they can find a "great job" after school making use of their USUSat experience. The evidence of this for the USUSat III team is both abundant and outstanding. Students in the USUSat program were directly targeted and sought after by both government and the aerospace industry and most graduating members received multiple job offers. Even students who were mediocre scholastically were sought after and rapidly hired because of the particular experiences

the USUSat program gave them. It was very clear to all students involved that the USUSat experience created opportunities for them that would not have been possible otherwise. One graduate student system lead accepted a job offer 5 months before graduation. The particular company was so impressed with him that they recruited other members of his team based on his recommendations. Although fortunate for the students, this intense recruiting has weakened the USUSat program as students who had planned to undertake masters programs were recruited away as undergraduates. This has broken the training process of future system leads and the re-training of systems leads from scratch by faculty and professionals is taxing of their donated time.

The strong space curriculum at USU draws approximately 35 to 40 new undergraduate and graduate students a year from the ECE and MAE departments into the space courses shown in Figure 3. This is about 20% of the potential pool of students from the two departments and is some indication of the interest in space engineering among the students. Approximately 70% of these individuals are US citizens. It is unclear how much of the total interest in the space engineering area at USU is due to available courses and how much is due to the excitement over the USUSat program because the two programs have grown in parallel with each other over the last decade. Either way the primary Air Force goal of bringing students into this career area is being achieved. At the beginning of the USUSat III program a recruiting meeting was held and approximately 80 new students showed up indicating broad interest in space. Crucial to any student satellite effort is a team of dedicated and high quality students available for the project. While interest was high there turned out to be problem of student availability throughout the USUSat III effort.

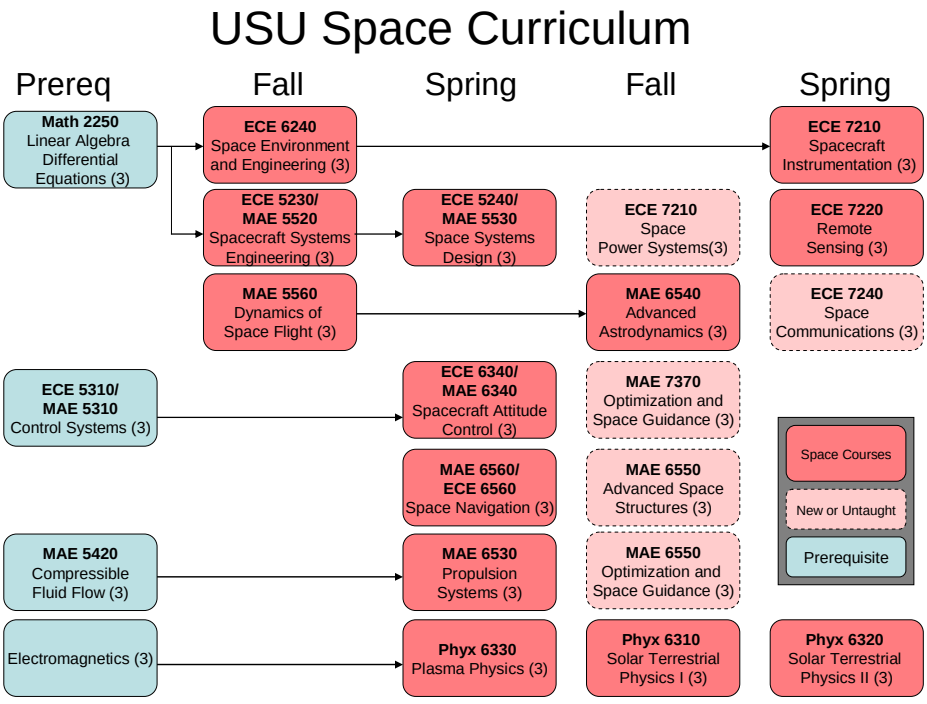

Figure 3 Utah State University Space Curriculum

The USUSat program has been built up around the concept of volunteerism and as a topic area for senior design projects or thesis research. About four or five student positions are directly supported by the USUSat program. One or two additional positions are typically made available on externally funded research that is synergistic with USUSat. The USUSat program is not directly a part of the curriculum in either the ECE or MAE Departments. The only way students can receive academic credit for participating is though a senior design or a graduate research project that is individual to them. The USUSat team, supported in this way, has generally been small and vulnerable to the loss of key students to other research enterprises at USU or job opportunities. On this basis the USU team does not appear to be as well motivated as those at the schools which ranked highly in the competition. These schools approach the student design program differently. Such programs are fully integrated as part of the curriculum for which they get academic credit. Students must choose from a number of projects including the student satellite program to complete their undergraduate or Master of Engineering design project requirements. They are graded on their participation and contribution to the effort and the project funding is used for hardware only. All three schools which placed highly in the University Nanosatellite Competition had student teams motivated in this way. It appears unlikely that USU's volunteerism approach to the student team will be able to successfully compete in the future. This is in large part due to waning motivation of the faculty and professional advisors that are critical to the program.

It has become apparent that the USU faculty and SDL professionals who have supported the USUSat program over the past seven years have not received sufficient compensation to maintain interest in the program. Compensation is loosely used in this context to describe salary and work load as well as the more nebulous concepts of expected return on invested time or personal satisfaction. Compensation could take the form of summer salary, reduced teaching loads, professional recognition, additional proposal opportunities. An indication of this problem was manifested in the middle of the USUSat III program. Mechanical engineering undergraduate students were unable to use the USUSat program to fulfill their senior design requirements. None of the MAE faculty would take responsibility for the program in accordance with the department policies for the senior design program. The faculty and administration involved made a decision based on the perceived value of the USUSat program and its history of compensation for faculty. This decision directly affected the available time of MAE students involved with the program and several effectively stopped contributing. The unfolding of these events had a devastating effect on the morale of the entire team which affected their productivity. Without a well motivated support team of professionals and faculty the USUSat program is not sustainable.

The successes and failures of the USUSat program are multi-faceted issues all tied to the available resources, or lack thereof. It is clear that the program provides an unparalleled attraction for students to begin careers in space engineering. This is evidenced by the student interest in the program when recruiting. The need for more graduates in this area

is demonstrated by the strong response of industry in seeking out and hiring the USUSat participants. Not all of those students expressing interest actually can participate due to time constraints associated with other course work or the need for employment. Some students lack confidence and need more faculty or professional support to become fully involved. Both of these issues come down to a fundamental lack of resources for USUSat. Obviously, if more funding were available either though a larger AFOSR grant or more industry contributions then more students or some faculty salary could be paid. One way resources can be attracted, without additional funding, is to build the program into the curriculum. If students received credit towards their degrees while working on USUSat, such as senior project credit, then more students can participate. If faculty can count working with students on USUSat as teaching a senior project course then more resources are effectively available for faculty salary. This approach simply mimics what appears to be successful at other universities.

More resources could be made available by scaling back the required effort to achieve success for the USUSat program. In this context success is defined as producing flight ready hardware. This could be accomplished by having the students tackle a less technically demanding spacecraft than what was done for USUSat III. A spacecraft with simpler communications, attitude control, and instrumentation would be more achievable with the given resources. The converse is that the students would not be as challenged nor be introduced to the complexity that arises in more capable spacecraft. One of the reasons USUSat students were attractive for hiring by industry was that they had a “real world” experience. This is additionally complicated because the winner of the competition must additionally compete with other Department of Defense missions in the Space Experiments Review Board process for a flight. A spacecraft with a simplistic mission is unlikely to compete well and thus unlikely to fly but more achievable by students.

There are other ideas that could improve the USUSat program that are outside of the USU team control but fall within the purview of AFRL or AFOSR. These include encouraging AFRL sponsored spacecraft component and space systems research at those schools participating in the University Nanosatellite Program. This would provide additional motivation for faculty to be involved. Another possible improvement would be a program where by more university built satellites are flown. The criteria being that they must achieve a level of readiness instead of all competing for a single launch opportunity. Perhaps another approach to a competition where more of the schools could win would be a program with a common science or technology mission. All schools would be flown and then judged on how well they achieved the assigned mission. An example would be all spacecraft trying to image clouds or navigate relative to a mother spacecraft.

Utah State University proposed and was accepted into the latest round of the Air Force University Nanosatellite Program. Dr. Charles Swenson, the PI, is on sabbatical leave from USU in 2007-2008. The program is being run by the very capable Mr. Chad Fish from the Space Dynamics Laboratory. The expectations are that some changes can be made to improve the USUSat program including a dedicated course for senior project credit. Some interest has been shown by other USU faculty in driving changes in the program with the absence of Dr. Swenson.